Kenaf and Canola—Selenium Slurpers

Kenaf and canola plants do a good job of cleaning up soil and water contaminated with selenium, Agricultural Research Service studies in California show. Besides helping detoxify water and reclaim selenium-laden soil, canola that's enriched with moderate levels of selenium may provide a safe, nutritious feed for livestock, according to preliminary ARS results.

Though selenium is an essential micronutrient for humans and other mammals, too much of it can harm people and animals alike. Using kenaf or canola for what's known as bioremediation—biological cleanup of soil or water—could improve underground water supplies destined for our homes or could improve the safety of water that ends up in ponds and lakes used by wildlife.

Selenium-accumulating kenaf and canola plants have value beyond environmental cleanup chores. Kenaf, a fast-growing, deep-rooted relative of okra and cotton, makes a bright, high-quality paper that resists yellowing. Better yet, that papermaking doesn't require the toxic chemicals needed for converting wood pulp into paper.

What's more, kenaf can also be processed into acoustic tile, cat litter, bedding for horses or other animals, composite board for construction, mats for erosion control and grass seeding, or pads for cleaning up chemical or oil spills.

Canola, a member of the mustard family, yields a healthful vegetable oil. Forage made from the crop is a desirable feed for farm animals because it has about as much protein as alfalfa, a premier forage and hay crop. And canola plants first used to cleanse or detoxify high-selenium soil or drainage water might next be sold as a value-added feed for livestock in regions where soils don't provide enough of this nutrient.

"In the United States, selenium deficiency is typically a bigger problem than selenium toxicity," says ARS soil scientist Gary S. Bañuelos. "Selenium deficiency is a major problem for livestock or wildlife in at least 37 states and costs beef, dairy, and sheep producers an estimated $545 million in losses every year. Ranchers in selenium-poor regions either inject their animals with the mineral or add selenium supplements to feed."

STEVE DOWNEY (K4572-15)

Soil scientist Gary Bañuelos evaluates canola plants grown for cleaning selenium-rich soils. In studies on livestock, he is testing the potential use of high-selenium canola forage as feed.

Bañuelos, who is with the ARS Water Management Research Laboratory in Fresno, California, has not only scrutinized selenium uptake by kenaf and canola, but has also looked at the selenium-recycling prowess of other cultivated crops, including grasses, legumes, and even vegetables like broccoli, cabbage, Swiss chard, and collard greens. And he has investigated the ability of wild plant species like Indian brown mustard to suck selenium from the soil.

The site of these experiments—California's central valley—is America's number one agricultural region. Ironically, growers there struggle with an overabundance of selenium on the west side and a paucity on the east.

Feeding Canola to Livestock

In collaboration with ARS soil scientist Henry F. Mayland at Kimberly, Idaho, Bañuelos examined the effects of feeding selenium-enriched canola to lambs and dairy cows. Grower John E. Diener of Red Rock Ranch in Five Points, California, produced canola for the experiment.

"Of course it's too early for us to recommend feeding of selenium-enriched hay to livestock," cautions Mayland. "But these preliminary results look promising."

The study was likely the first to use, as an animal feed or supplement, canola that had been grown specifically for the task of pulling naturally occurring

JACK DYKINGA (K4572-14)

Bañuelos examines the effects of salt, boron, and selenium on the roots of kenaf. This crop is much taller than canola and has a deeper root system for cleaning up soils.

selenium from the soil.

Half the animals in the tests were fed canola that had been irrigated with high-selenium drainage water (200 to 500 parts per billion). Water for irrigating the canola fed to the other lambs and cows had only 10 parts per billion selenium.

Ten lambs nibbled freshly harvested canola for 7 weeks; eight dairy cows ate dried, coarsely ground canola as part of their total rations for 20 days. The amount of selenium in canola was meticulously measured to make sure it was at a safe level—less than 5 milligrams per kilogram of dry matter. That's the equivalent of about a small pinch of selenium in a bale of hay.

The scientists also checked selenium levels in blood, cow's milk, and other samples. "All of the animals," reports Bañuelos, "remained healthy throughout the study. None showed signs of getting too much selenium from the canola."

An added bonus: An informal taste test of milk produced by the canola-fed cows indicated no detectable difference in flavor. Plus the animals' weight gains—essential to ranchers' profits—were about the same, regardless of the selenium content of the feed.

But what about the selenium that ends up in the manure of animals that eat higher-selenium canola? Results from an earlier ARS study suggest that dangerously high levels of selenium are unlikely to cycle into pasture plants from the manure. That means the plants should still be safe for animals to graze.

Selenium in cattle manure is predominantly of the organic forms that are less available to plants than the inorganic forms. That's according to an earlier experiment reported by Husein A. Ajwa at the Fresno lab, along with Bañuelos and Mayland. They used potted canola and tall fescue plants grown in soils treated with manure or other selenium sources.

Big Kenaf

For the selenium-recycling study with kenaf, Bañuelos and co-researchers grew some 120,000 plants on a 1-acre site near Los Baños, California. He performed the kenaf analysis in collaboration with Patrick T. Treffey of 3-Way Farms, Watsonville, California; Charles G. Cook, formerly with ARS; and David A. Dyer of USDA's Natural Resources Conservation Service.

The hardy plants shot up nearly 15 feet in only about 6 months. "Kenaf," says Bañuelos, "took up at least 25 percent of the soluble selenium to a depth of about 3 feet. Canola, which has shallower roots, used about 50 percent of the selenium to a depth of about 2 feet."

Though kenaf is less tolerant than canola of very salty drainage water, that doesn't take this plant out of the running. "Irrigation wastewater that's high in selenium," Bañuelos says, "isn't always overloaded with other salts. Besides, kenaf plants rapidly produce a tremendous amount of biomass, meaning that in a very short time you have a very big plant cleaning up a lot of soil and water for you."—By **Marcia Wood,** ARS.

This research is part of Water Quality and Management, an ARS National Program (#201) described on the World Wide Web at http://www.nps.ars.usda.gov/programs/nrsas.htm.

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